NORTHEASTERN FOREST EXPERIMENT STATION

Semiannual Report

Watershed Management Research

April 1, 1969 - September 30, 1969

Table of Contents

NE-1601 - WATER YIELD IMPROVEMENT NE-1

Summer flood at Hubbard Brook NE-1
Spring flood threat does not materialize NE-2
Mislocation of our experimental forests NE-2
Cooperation NE-2
Treatments NE-4
Personnel NE-4

NE-1602 - FLOODS AND WATER YIELD NE-5

A new watershed treatment NE-5
The story of the roasted seedlings NE-8
Local climate and pan evaporation NE-10

NE-1603 - FOREST HYDROLOGY AND URBAN FOREST ENVIRONMENT NE-14

NE-1604 - STREAM REGIMEN AND WATER YIELDS NE-15

Radiation relationships NE-15
Field environmental laboratory NE-15

NE-1605 - RESTORATION OF STRIP-MINED LANDS NE-17

NE-1606 - MANAGEMENT OF STORM RUNOFF NE-19

Partial-area contributions NE-19
Excess precipitation.....NE-20

PUBLICATIONS NE-22

NORTHEASTERN FOREST EXPERIMENT STATION

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NE-1601 - WATER YIELD IMPROVEMENT, Durham, New Hampshire

Summer Flood at Hubbard Brook

New England summer precipitation is seldom of the duration or intensity necessary for causing flood flows. An exception occurred this past summer, however, when 5.2 inches of rain fell between 1800 on July 27 and 2400 on July 29. The resulting runoff caused flood damage throughout central New Hampshire and Vermont and provided us with the first summer flood event since start of streamgaging at Hubbard Brook in 1955.

Differences in storm runoff from our cleared and forested control watersheds were enlightening. Streamflow in area-inches for the several days surrounding the storm was as follows:

	Forested Control	Cleared Watershed
7/27	.01	.06
7/28	.04	.31
7/29	.83	2.09
7/30	.85	1.26
7/31	.20	.34
8/1	.08	.20
Total	2.01	4.26

Maximum peaks occurred simultaneously at 0700 on the 29th and were 109 c.s.m. on the control and 323 c.s.m. on the cleared watershed.

The storm ended a prolonged dry period--only 1.8 inches of rain had fallen on the preceding 30 days. The daily streamflow totals show that the available moisture storage on the transpiring forested control was over 2 inches greater than that on the cleared area. The implication is that the flood damage would have been worse if sizeable land areas were cleared of forests. However, ordinary cutting would not have as great an effect as on this experimental cleared watershed where all trees had been cut and herbicides applied to control regrowth.

The above event has served as a reminder of the slight but ever-present summer flood potential in New England. When considering the increased water yields resulting from forest clearing, we must weigh the value of the increases against the existing flood potential.

Spring Flood Threat Does Not Materialize

In the last semiannual we mentioned that the '69 spring snowpack at Hubbard Brook held a record 18 inches of water and that the flood danger was extreme due to the pack persisting late into the spring. We now report (with mixed emotions) that the flood threat did not materialize. The snowpack disappeared during a highly improbable (for New England) series of warm, dry days. Meltwater sustained streams at high levels for several weeks but the maximum peak flows were well below flood stage. For example, streamflow for April from our forested control watershed totaled 19.9 area-inches, but the maximum peak did not exceed 70 c.s.m. (flood stage at Hubbard Brook is approximately 100 c.s.m.).

Mislocation of our Experimental Forests?

The accompanying map shows mean annual precipitation for the eastern United States. On it are marked the locations of the three Forest Service experimental watersheds in the east: Coweeta, Fernow, and Hubbard Brook. It is interesting that these are within three of the four small areas of high precipitation in the east (the other is the Adirondacks). Annual precipitation is usually given as 48 inches for Hubbard Brook, 56 for Fernow, and 80 for Coweeta, while rainfall over practically all of the region is in the 40- to 48-inch range.

We should be cautious in extrapolating water yield results from these Forests to other areas, keeping in mind that the lower rainfall over most of the region allows larger soil water deficits to build up in the summer than we experience on the experimental areas. This affects flood potential, fall recharge, the relation of actual to potential ET, etc., etc. We conclude that the initial selection of locations for these experimental areas was unfortunate with respect to being so-called representative of surrounding areas in terms of precipitation.

On the brighter side, experiments on these watersheds show substantial increases over a wide range of precipitation (48 to 80 inches).

Cooperation

Our cooperators, Yale and Cornell Universities, recently received approval of a more than $1/3 million grant for studies at Hubbard Brook on ecosystem nutrient cycling. This is the latest in a series of grants from the National Science Foundation dating from 1963. Part of the funds will support a full-time position at Hubbard Brook and help defray possible costs for initiating our second watershed treatment.

S. Ste. Marie
Chicago
Lansing
Detroit
Buffalo
Pittsburgh
Harrisburg
Philadelphia
New York
Albany
Boston
Hartford
New Haven
Burlington
Portland
Concord
Carribou
Columbus
Indianapolis
Springfield
Lexington
Charleston
Richmond
Norfolk
Raleigh
Nashville
Knoxville
Memphis
Wilmington
Columbia
Atlanta
Birmingham
Charleston
Jackson
Jacksonville
Pensacola
HUBBARD BROOK
FERNOW
COWEETA
45°
40°
35°
30°

Treatments

Treatment plans call for Watershed #4 (about 89 acres) to be strip-cut in three phases involving a span of perhaps 4 years, starting in the fall of 1970. The east-west oriented strips will be about 82 feet wide and cutting will progress in a north to south direction across the south-facing watershed. The treatment will follow recently recommended cutting techniques for regenerating high quality northern hardwoods, particularly yellow birch. Our purposes for the treatment are to determine the extent of nutrient loss from the ecosystem resulting from timber harvesting, to follow the translocation of nutrients between strips as they are cut and regenerated, and to observe micrometeorological and soil water regime changes with the progressive strip cutting and regeneration. This treatment should provide valuable ecological and hydrological data intermediate between an undisturbed forest and the drastic cleared condition imposed in Watershed #2.

Personnel

Wayne Martin, a University of New Hampshire forestry graduate with several years of forest survey experience with the Forest Service, has filled a vacancy at Hubbard Brook. The job formerly was a technician position but has been upgraded to a professional status.

-- R. S. Pierce
C. A. Federer
J. W. Hornbeck

Seminnual Report
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Project 1602 - Parsons Timber and Watershed Laboratory
Parsons, West Virginia

A New Watershed Treatment

Several years ago, Ken Reinhart and others were reporting effects on water yield of various forest management methods at the Fernow Experimental Forest. The following table may refresh fading memories:

Table 1.--Original Fernow watershed treatments and first-year streamflow increases

Watershed number	Treatment	Streamflow increase (inch)	Years for increase to disappear
1	Commercial clearcut	5.1"*	5
2	Diameter limit	2.5"*	2
3	Intensive selection	0.3"	1
4	Control	---	--
5	Extensive selection	1.0"	2

*Significant at the 5% level

Since the original intensive selection treatment in 1958-59, watershed #3 has twice been retreated the same way. With less than 15 percent of the basal area cut in any of these treatments, streamflow seemed to increase slightly but never to statistically significant levels. Although these retreatments were a part of the timber research program and cost us nothing, from the watershed viewpoint, further retreatment seemed futile in light of this well-established pattern of non-response. Thus, the way was clear to assign another study to watershed #3.

The following excerpt from a local newspaper article entitled "governmental rape" suggested a needed and timely study for this watershed.

> The Chamber of Commerce has gone on record as being opposed to the timber sale in the National Forest running from above the Georgia Pacific mill to Big Clady Run (above North Bend). Two hundred and fifty-six acres are to be clear-cut with only 100 yards being left between the cut and the river. The ramifications are that with this cut the Forest Service is putting that area out of timber production for 100 years by its own admission. This means that watershed control will be lost. Our pure water will be gone, in fact the river will dry up; and in times of heavy rains there will very possibly be heavy and damaging floods and the game and fish which help to draw the tourist into this area will be no more.

Such claims are so patently false that refutation seems a waste of time. Nevertheless, the controversy between these forest users and the Monongahela National Forest now extends from here to Washington. One way to help resolve it is to place a local watershed under conventional even-agedmanagement and widely publicize what actually does happen.

We began clearcutting Watershed #3 in July, 1969 and by May 1, 1970 (the start of our next growing season) we plan to have it done. Over 700 MBF of timber and 900 cords of pulpwood will be taken from this watershed, these products to pay treatment costs. Understory trees were basal-sprayed with 2,4,5-T in diesel oil. The road system is essentially that used since 1958 which has caused no measurable damage to water quality. Perhaps the only new variation from a conventional clearcut treatment in our watershed management is a leave-strip extending about 1 chain either side of the permanently flowing stream. Its purpose is to hold down water temperature by shading and to preserve a high-forest environment near the stream. A few mature trees were cut on a selection basis so that this productive streamside area is not lost as a timber source. No road-building or logging equipment is permitted even to approach the leave strip.

Besides obtaining conventional precipitation and streamflow data, we are measuring stream temperature and turbidity. In addition, the Forest Service Water Quality Laboratory at Ely, Minnesota is analyzing monthly samples of low flow and storm flow from the treated and control watersheds. These data will provide information on nutrient losses from forest land managed by conventional even-aged methods.

By these means, we hope to determine whether or not forest land can be managed by even-aged methods to increase annual water yields and late summer streamflow without increasing the flood hazard. We believe that some damage to water quality is inevitable but plan, by careful road management and the streamside strip, to hold these damages to innocuous levels. Most important, we hope to show that immediate revegetation will quickly absorb and recycle nutrients released by decay of slash and litter following clearcutting. Such a study, under local conditions, should help lay to rest the locally widespread but totally unjustified misinformation against even-aged management of eastern hardwoods.

--James H. Patric

The Story of the Roasted Seedlings

This past summer we enclosed several potted seedlings in polyethylene plastic bags for a transpiration study. By using silicone liquid rubber and florists "stickum", we were able to get a water tight seal around the stems. A plastic tube extending down to the soil surface was incased in the seal so water could be added. This tube was plugged with a rubber stopper, except when water was being added. The pots were weighed periodically to determine water loss.

There was some debate at the laboratory concerning the effect of heat on the seedlings, but no one seemed overly concerned. In approximately one week, brown spots began to appear on some of the leaves. Examination of several seedlings revealed that their stems had been killed between the seals and the ground line. The bark had a burned appearance and the cambium and xylem were hard and dry with a brown discoloration. The average length of affected stems was about 4 inches. Water evidently was being conducted upward through the dead portion of the stem because leaves on most of the plants remained green and did not show symptoms of damage for several weeks. Yellow poplar was the first to show damage symptoms with black cherry, red oak and white pine following in that order. There was a distinct enlargement of the stem above the killed section.

Being prepared for the worst, as the worst does occasionally happen, we bagged the seedlings held in reserve, covered the top of each bagged seedling with aluminum foil, and placed them under a 25 percent shade screen. Maximum - minimum thermometers were inserted in the plastic watering tubes in some bagged seedlings, both with and without aluminum foil. Some of each were placed under the shade screen and some were left in the open. Maximum temperatures were recorded for 31 days. The results are shown in Figure 1. Maximum temperature under the clear plastic bags averaged 30° higher than those recorded under the aluminum foil. The average maximum temperatures under the aluminum foil were 86° F. versus 116° F. for the clear plastic bags. The highest temperature recorded was 140° F. under a clear plastic bag. The 25 percent shade screen apparently had no effect on bag temperatures. Actually, slightly higher temperatures were recorded under the shade. The variation between individual pots receiving the same treatment was quite large.

The moral of this story is, if you do not want to roast seedlings enclosed in clear plastic bags, cover them with aluminum foil as it keeps the heat out and the juices in. This moral is substantiated by the fact that the seedlings covered with aluminum foil lived very happily for two months during the hottest part of the summer.

--James N. Kochenderfer

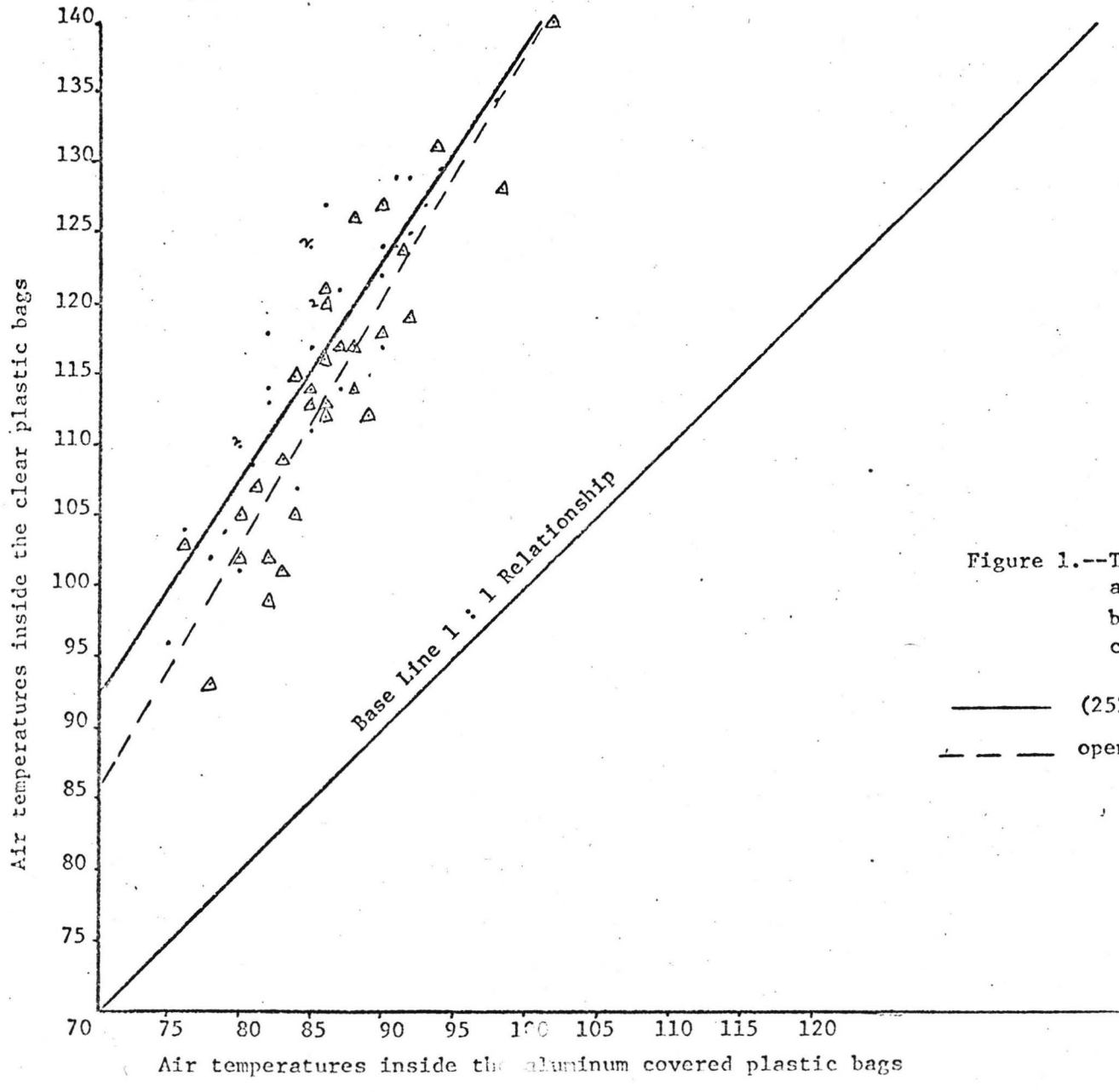

Figure 1.--Temperature relationships between aluminum covered vs clear plastic bags under open and shaded (25%) conditions.

——— (25%) shaded •

— — — open △

Local Climate and Pan Evaporation:

What local climatic parameters most significantly influence daily pan evaporation? To evaluate our daily weather observations and as a follow-up to a recent paper on pan evaporation studies by Jim Patric, we tried to answer this question. In addition, we were interested in correcting, for local conditions, the general coefficient of .70 which is applied to pan evaporation to estimate potential ET.

To do this we performed a two part analysis on the daily climatic data collected at the Timber and Watershed Laboratory during the 1967-68 water years. Through regression analyses, we tried to find the best, yet simplest, expression for daily pan evaporation in terms of the other climatic parameters we monitor. The parameters--in addition to pan evaporation--are solar radiation, max-min temperature 4.5 feet above the ground, max-min water temperature in the pan, and wind speed above the pan. We also have daily barometric pressure from nearby Elkins Airport.

Using the "shotgun" approach, we expressed evaporation as a function of a variety of combinations of the other parameters. Table 1 lists the equations tried as well as the multiple correlation coefficients and the residuals of each.

Table 1.--Equations to estimate pan evaporation from climatic data

Equation number	Equations	R^2	Residuals $\hat{X}_1$
1.	$X_1 = b_o + b_1X_2 + b_2X_3 + b_3X_5$	.901	.026
2.	$X_1 = b_o + b_1X_x + b_2X_3 + b_3X_5 + b_4X_6$	.902	.026
3.	$X_1 = b_o + b_1X_2 + b_2(X_3+X_4)$	.883	.028
4.	$X_1 = b_o + b_1X_2 + b_2\frac{(X_3+X_4)}{2} + b_3X_5 + b_4\frac{(X_6+X_7)}{2}$	.901	.026
5.	$X_1 = b_o + b_1X_2 + b_2\frac{(X_3+X_4)}{2} + b_3X_3 + b_4X_5 + b_5\frac{(X_6+X_7)}{2}$	.905	.026

X_1 = Daily Pan Evaporation
X_2 = Daily Rad. (Ly)
X_3 = Max Air Temperature
X_4 = Min. Air Temperature
X_5 = Wind Speed (MPD)
X_6 = Max Water Temperature
X_7 = Min Water Temperature

Everything considered, the best estimators of daily pan evaporation are solar radiation, wind speed and max daily temperature (eq. 4). Although it is significant in reducing the sum of squares, removing the wind from the equation (eq. 3) doesn't reduce the fit by very much. The relative unimportance of wind in our localized equation contradicts what appears in the literature. This is probably due to low readings we get as a result of a hedge near the shelter. Addition of the other variables (eq. 2,4,5) improves the multiple correlation some, but does not influence the residuals. The results of the analyses were quite consistent with what appears in the literature, both in terms of the variables which are significant and the correlations associated with each equation. This acted as a check on the accuracy and consistency of our data.

In the second phase of the study, we wanted to correct the annual class A pan coefficient for local climatic conditions. On occasion, we use pan evaporation to rapidly estimate ET over short periods. However, in the past we used the gross factor of 0.70. To correct [1/] the factor for local use, we used Kohler, Nordenson, and Fox's(1955) equation and U. S. Weather Bureau Program to compute lake evaporation and to determine the coefficient which must be applied to our daily pan evaporation to estimate this lake evaporation.

The equation used to estimate lake evaporation for local conditions was:

$$E_L = 0.70\ E_p + 0.00051 p \prec (0.37 + 0.0041\ U_p)\ (T_o - T_a)^{0.88}$$

Where:

E_L = Lake Evaporation (in/day)
E_p = Pan Evaporation (in/day)
P = Atmospheric Pressure (mean daily)
$\prec$ = Coefficient from Kohler's tables
U_p = Wind speed (M.P.D.)
T_o, T_a = Mean Water, Mean Air Temp.

The corrected monthly coefficient for this area averages 0.78 for the growing season but varies from .76 to .79. This represents only a slight correction and very close check on the 0.76 factor computed for this region by Kohler, Nordenson and Baker (1959).[2/]

1/ Kohler, Nordenson and Fox. Evaporation from pans and lakes. U.S.D.C. Weather Bureau. Res. P. No. 38. 1955.

2/ Kohler, Nordenson and Baker. Evaporation maps for the United States. U. S. D. C. Weather Bureau. Tech. Paper 37, 1959.

It was interesting to note that in the cover letter from Nordenson (returning the computer output) he was able to detect an influence on wind speed from the hedge behind the lab:

> The coefficient averages about 0.78. This high coefficient is probably due to the fact that this station apparently is a well protected site since the daily pan wind movement is low. Low winds would tend to give higher water temperatures which in turn would increase the coefficient.

--Charles A. Troendle

Semiannual Report
April 1, 1969 - September 30, 1969

NE-1603 FOREST HYDROLOGY AND URBAN FOREST ENVIRONMENT
Upper Darby, Pennsylvania

What did you do during the past 6 months?

Howard Lull: Mainly, I wrote. Took a country-wide review paper, Management possibilities for water yield, through two drafts and sent the last draft to Henry Anderson, John Hewlett, and Jerry Horton for review. It's for next year's FAO-Moscow Conference, Hewlett reading. Ken Reinhart and I read 13 reviews of our forest-floods paper: 11 pro with a few hurrays and 2 con. We'll wind it up in a Station Paper. Also, I rough-drafted 170 (of 250 planned) pages of a proposed USDA Bulletin Forestry and water and by Christmas will have a draft ready for Reinhart to chew on. Then we'll send our joint effort to Henry Anderson and Marvin Hoover to work over. With this quartet, all men of opinionated good-will, the manuscript will probably end up in the War Department. Peace!

Ken Reinhart: My main effort, in addition to routine duties as staff man for the Assistant Director, has been to prepare an abbreviated version of our forest-floods paper for presentation to the Watershed Management Section of the SAF at the October meeting, in Miami. I am also assisting in editing papers for the Proceedings of the International Symposium on the Ecology and Revegetation of Drastically Disturbed Areas.

Ed Corbett: I wound up the municipal watershed survey. Our questionnaire turned up over 750 municipal watersheds in the Northeast involving more than 2,000,000 acres of forested land. The acreage is 41 percent municipally owned and 13 percent privately held, while 36 percent and 10 percent is under State and Federal control respectively. Timber harvesting was allowed on 54 percent of the watershed properties and some type of recreation activity on 59 percent. Hunting, fishing, and hiking were mentioned most frequently as allowable recreation activities. When asked what problem areas were of greatest concern, watershed managers ranked water quality control first (59 percent), water yield improvement second (53 percent), and recreation problems third (45 percent). Twenty-eight percent of the managers indicated they had no major problems. Water quality impairment was mainly from domestic sources and recreation areas. Many managers also indicated they had problems with the color, odor, and taste of water collected in reservoirs.

In June I moved family and baggage to The Pennsylvania State University at University Park where I am taking course work in hydrology and related subjects courtesy of GETA. I packed several manuscripts to work on.

NORTHEASTERN FOREST EXPERIMENT STATION

Semiannual Report

April 1, 1969 - September 30, 1969

NE-1604, Syracuse, N. Y.

Radiation Relationships

Investigations into the radiation relationships of various types of vegetation cover are moving forward. A tramway was erected above a 30-year-old spruce plantation and several days data collected on the amount of incident and reflected shortwave radiation above the stand along the tramway. Information from this system will be presented in the next semiannual report.

In addition to the solar radiation measurements now being taken on our various tramways, a system of measurements is being inaugurated using an ISCO spectroradiometer. This system will involve point measurements of the radiation spectrum above and below the canopy.

Field Environmental Laboratory

The cooperative environmental lab at Warrensburg, New York provides some interesting information on root distribution in the 38-year-old Pinus resinosa Ait. plantation. Roots from a single dominent, 17-meter-tall, 20-cm-diameter tree were excavated. Following a clearcut and subdivision of the area around the tree into a 0.6-x 0.6-meter area grid system, all roots were excavated by hand in the AP and B horizons and by 0.3-meter-depths in the C strata.

Within each sampling grid unit, by horizons and strata-depth increments, the roots of the tree and combined roots of all other trees were separated into 5 size classes, collected, cleaned, dried, and weighed. Root depth penetration terminated in a mass of fine roots in a thick, very fine sandy-silty stratum below the coarse-textured solum at approximately 3 meters. Lateral root distribution was extremely variable, the maximum extent being approximately 6 meters from the stump. Some of the data from this investigation is presented in Table 1.

--Raymond E. Leonard

Table 1.--Dimensions of the sample Pinus resinosa tree within a 2 x 2 m spaced plantation.

AGE	39 years
DIAMETER BREAT HEIGHT	20.25 cm
TOTAL HEIGHT	17.10 m
CROWN LENGTH	8.67 m
WIDTH OF CROWN BASE	3.83 m
WIDTH OF HALF CROWN LENGTH	2.70 m
MAXIMUM LATERAL ROOT EXTENT	8.92 m
MAXIMUM ROOT DEPTH PENETRATION	2.67 m

	DRY WEIGHTS		
	grams	percent of above-ground	percent of total
NEEDLES			
1-year-old	4,647	2.93	2.46
2-year-old	3,295	2.07	1.74
>2-year-old	6,313	3.97	3.35
Needle Total	14,255	8.97	7.55
BRANCHES w/bark	26,215	16.52	13.92
BOLEBARK	11,141	7.03	5.92
BOLEWOOD	107,081	64.48	56.83
TOTAL ABOVE-GROUND	158,692	100.00	84.22
ROOTS			
>2.0 cm	22,166	---	11.76
2.0-1.0 cm	3,100	---	1.70
1.0-0.5 cm	1,705	---	0.90
0.5-0.1 cm	1,703	---	0.90
<0.1 cm	1,050	---	0.52
Root Total	29,724	---	15.78
GRAND TOTAL	188,416	---	100.00

NORTHEASTERN FOREST EXPERIMENT STATION

Semiannual Report
Watershed Management Research

April 1, 1969 - Sept. 30, 1969
Restoration of Strip-Mined Lands, Project 1605

Grant Davis
Project Leader

General

We are anxiously awaiting the arrival of our new soil scientist, Dr. David H. Van Lear, formerly with the University of Florida.

Members of the 1605 project attended the International Symposium on Ecology and Revegetation of Drastically Disturbed Areas at Pennsylvania State University from Aug. 3 to 16. There were participants from 14 countries and 18 states at the meeting, and over 60 papers were delivered during the two-week session. A one-day field trip was taken during the first week, and the symposium closed after a three-day tour of northern W. Virginia and S.E. Ohio. Co directors of the symposium were Grant Davis and Dr. Russell J. Hutnik from Penn State. Nellie B. Caldwell typed the questions and answers which were taped following each paper. Ken Reinhart is helping with the editorial chores to speed the process of publishing the proceedings.

Papers presented by the 1605 staff are as follows:

William A. Berg (former project member) and Willis G. Vogel:
Aluminum and manganese toxicities of plants in acid coal-mine spoils.

W. G. Vogel and William A. Berg:
Fertilizer and herbaceous cover influence establishment of direct seeded black locust on coal mine spoils.

Miroslaw M. Czapowskyj:
Performance of red pine and Japanese larch planted on anthracite coal breaker refuse.

Willie R. Curtis:
The effects of strip mining on the hydrology of a small mountain watershed. Subsurface moisture relations of graded strip-mine spoils.

Grant Davis:
Comparison of fall and spring planting on strip-mine spoils in the bituminous region of Pennsylvania.

William T. Plass:
Genetic variability in Virginia pine influences survival and growth on acid spoil.

G. P. Williams Jr.:
Site physical characteristics and spoil outslope mass instability.

WATERSHED MANAGEMENT RESEARCH

April 1- September 30, 1969

NE-1606, Columbus, Ohio

R. Z. Whipkey

Partial-Area Contributions

This past May, a group of hydrologists and hydraulic engineers met at the ARS Sleeper's River Watershed to discuss partial-area contributions to the storm hydrograph. The group, hosted by Johnson, ARS, included Troendle and Whipkey, Forest Service; Hewlett, Nutter, and Tsukamota, Univ. of Georgia; Ragan, Univ. of Maryland; Downer, Univ. of Vermont; Dunne, McGill University; Surhan, IBM; Ryckborst, Water Authority, Ottawa; Amerman, ARS; and Dingman, U.S. Army.

We were primarily concerned with storm runoff, how it occurs, measurement, and simulation and prediction techniques. The group concurred that storm discharge in almost all instances originates as subsurface stormflow. Data and opinions varied, naturally, as to origin and runoff processes of such subsurface stormflow.

Evidence presented by the group from their studies pointed out that watersheds are generally dynamic in that flow-contributing areas change from time period to time period and within storm periods. Dependent on location, geomorphology, internal structure, antecedent moisture and storm conditions, storm discharge-producing areas can shrink or swell. With increasing wetness, the effective channel systems may grow so that primary first-order streams become multi-ordered. This is a factor causing non-linearity of runoff.

The group was pretty much in agreement that the parking-lot concept of total area contribution, basic to flood hydrograph synthesis and flood-routing techniques, is not applicable for most natural watersheds. Those hydrologists working with conceptual models felt it necessary that we consider partial-contribution areas in order to rationally generate prediction hydrographs that have any generality. It was agreed that basic studies on flow behavior from varied slopes under assorted physiographic conditions would strengthen computer input, but that such information is not presently available. Specific mention was made of storage properties of watersheds and stream channels and permeability characteristics of watersheds.

The meeting was interesting, informative, and valuable, largely in that researchers from different areas and agencies (most of them engineers) are independently coming up with about the same results and conclusions concerning storm runoff.

Excess Precipitation

The past quarter surprised us and caught us with our storm runoff facilities down. Why? Well, we finally received storm discharge during the "dry months." July finally gave us storms that flood hydrologists dream of--after a dry winter and spring, but a somewhat wetter than normal June. It must not be inferred that we object to storms--Oh no, we just don't like them when we're not prepared to measure them.

It all started in June. Shortly after our summer field help reported, we dismantled our main plots to put in new rainmaker and flow collection systems. But even worse, 10 years of working in east central Ohio had taught us that shortly after summer begins rainfall is dependably scant. So we felt safe in starting major excavations in the stream channel of our Number 1 watershed. (Our objective is to eventually measure hydrologic effects of subsoiling treatments on the watershed.)

But without warnings on July 4th tornadoes struck northern Ohio and in the aftermath violent thunderstorms occurred. During the next 30 hours, 7 inches fell on the Dover Experimental Area. We were fortunate in being on the edge of the storm for amounts of up to 12 and 14 inches fell in localities just 30 to 50 miles away.

The loss of lives, homes and personal property, crops, recreation facilities, and road and bridge damages in northern Ohio far overshadowed the setbacks to our summer field program. However, it was bad enough.

For the first time in 10 years of operation we observed surface runoff from the Dover Experimental Area. Granted, this occurred only from soil surfaces badly tramped and exposed by dozer and backhoe equipment; it was still damaging and frustrating. We quickly seeded rye grass on damaged sites and covered the more severely damaged spots with long strips of burlap in case of further storms. Just 7 days later we were the target of another unforeseen storm; this dumped about 2½ inches in 100 minutes.

And that did it! Our new plot sites terminate in trenches 100 feet long and up to 8 feet deep. Pumping, mucking, and drainage of these excavations could not stay ahead of subsurface inflow and we lost about 8 weeks of work (and what's worse, records).

Total rainfall for July was 14 inches or 50 percent of that falling the first 7 months. By the end of August, 69 percent of the 8-month total precipitation had fallen during the preceding 3 months.

After a summer of wallowing in mud and shovelling the same soil repeatedly from our old and newly opened gaging sites, the summer crew joyously left the muddy trenches to return to their respective schools. Fortunately, a dry September permitted completion of mopping up operations and we are now in the last stages of setting up our partial-area gaging system.

All in all, an interesting but frustrating summer. Although we regret the loss of so much of the storm record from our areas, we did gain some valuable observations and information about our area. With all the heavy downpour on pre-wetted soil, we still did not observe overland flow from undisturbed, litter-covered hillsides. In the periods between storms, streamflow amounts were the highest of any summer and persisted even after feeder streams from adjacent agricultural watersheds had subsided.

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